

# **Analysis of microscopic images by artificial intelligence**

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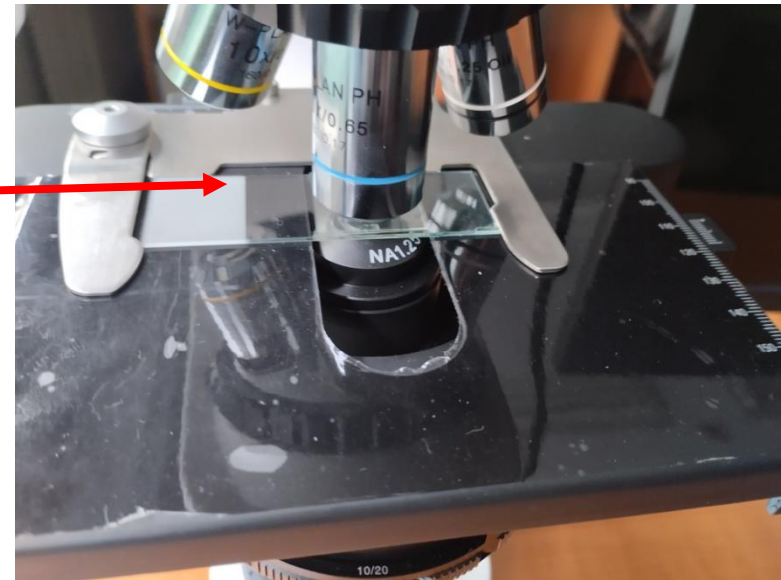
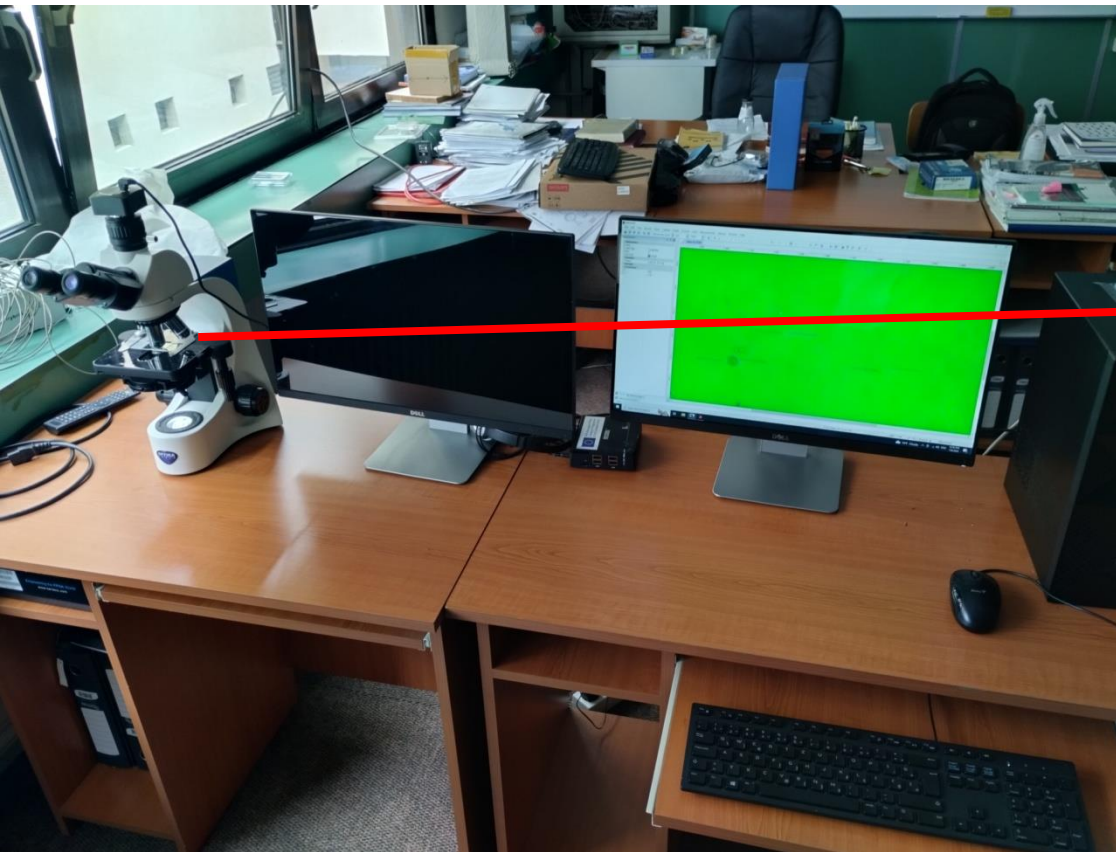
# Content

- Introduction about object detection and our **task:**
  - 1) **Sample preparation for microscopic images**
  - 2) **Labelling the images (bounding boxes)**
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- **Conclusion**

# Introduction

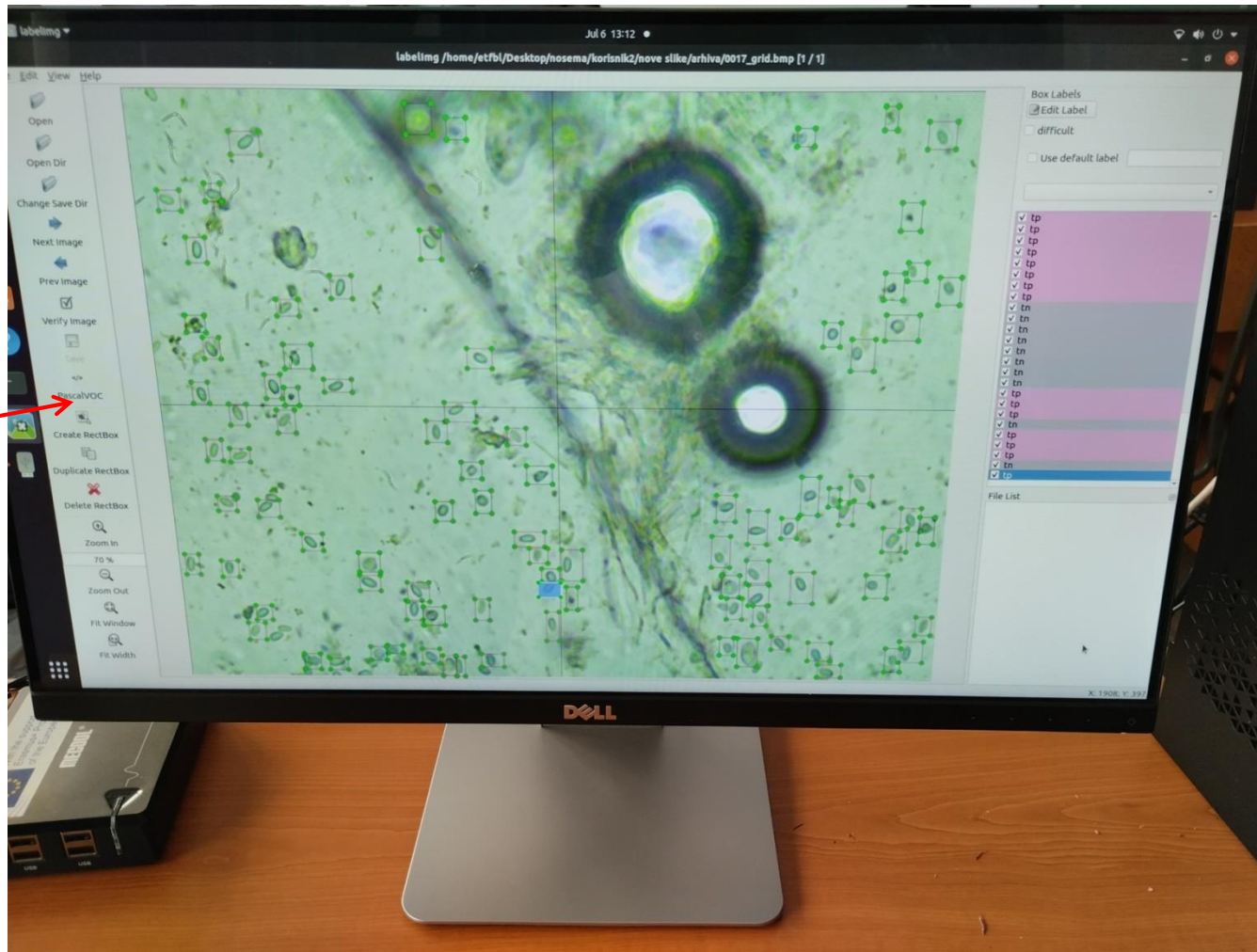
- In image classification tasks, we assume that there is only *one* major object in the image and we only focus on how to recognize its category.
- There are often *multiple* objects in the image of interest. We not only want to know their categories, but also their specific positions in the image.
- In computer vision, we refer to such tasks as *object detection* (or *object recognition*).
- Object detection has been widely applied in many fields:  
**self-driving needs to plan traveling routes by detecting the positions of vehicles, pedestrians, roads, and obstacles in the captured video images. Robots may use this technique to detect and localize objects of interest throughout its navigation of an environment. Security systems may need to detect abnormal objects, such as intruders or bombs.**
- In the next few slides, we will introduce an **deep learning (DL)** YOLO method for object (nosema cell) detection and automatic counting in microscopic images.

# 1) Sample preparation



# 2) LabelImg

<https://github.com/heartexlabs/labelImg>



# 3) Preparing dataset for training

MATLAB R2023a - trial use

HOME PLOTS APPS VARIABLE VIEW

New from Selection Rows Columns Insert Delete Transpose

VARIABLE SELECTION EDIT

C:\Users\Korisnik 01\Desktop\nozema\_boris\code

Current Folder

Variables - nosemaDataset

	1	2	3	4	5	6
imageFilename		nosema	not_nosema			
12	C:\Users\Korisnik 01\Desktop\nozema_boris\images\0017_grid.jpg	58x4 double	54x4 double			
13	C:\Users\Korisnik 01\Desktop\nozema_boris\images\0018_grid.jpg	55x4 double	19x4 double			
14	C:\Users\Korisnik 01\Desktop\nozema_boris\images\0019_grid.jpg	50x4 double	19x4 double			
15	C:\Users\Korisnik 01\Desktop\nozema_boris\images\0020_grid.jpg	29x4 double	28x4 double			
16	C:\Users\Korisnik 01\Desktop\nozema_boris\images\0021_grid.jpg	45x4 double	26x4 double			
17	C:\Users\Korisnik 01\Desktop\nozema_boris\images\0023_grid.jpg	[837,609,48,30]	53x4 double			
18	C:\Users\Korisnik 01\Desktop\nozema_boris\images\b1_grid.jpg	8x4 double	17x4 double			
19	C:\Users\Korisnik 01\Desktop\nozema_boris\images\b2_grid.jpg	4x4 double	31x4 double			
20	C:\Users\Korisnik 01\Desktop\nozema_boris\images\b4_grid.jpg	35x4 double	[]			
21	C:\Users\Korisnik 01\Desktop\nozema_boris\images\b5_grid.jpg	33x4 double	[]			
22	C:\Users\Korisnik 01\Desktop\nozema_boris\images\b6_grid.jpg	29x4 double	[928,734,42,41]			
23	C:\Users\Korisnik 01\Desktop\nozema_boris\images\b7_grid.jpg	48x4 double	[]			
24	C:\Users\Korisnik 01\Desktop\nozema_boris\images\b8_grid.jpg	60x4 double	[]			
25	C:\Users\Korisnik 01\Desktop\nozema_boris\images\b_cambodza10...	6x4 double	18x4 double			
26	C:\Users\Korisnik 01\Desktop\nozema_boris\images\b_cambodza5...	7x4 double	33x4 double			
27	C:\Users\Korisnik 01\Desktop\nozema_boris\images\b_cambodza6...	10x4 double	7x4 double			

Workspace

Name	Value
detector	1x1 yolov4ObjectDetector
i	1
I	1344x1824x3 uint8
idx	[3;5;2;4;6;8;7;1]
imageFilename	44x1 cell
imdsTest	1x1 ImageDatastore
imdsTrain	1x1 ImageDatastore
imdsValidation	1x1 ImageDatastore
info	1x1 struct
inputSize	[1344,1824,3]
k	4
labels	0x1 categorical
meanIoU	0.7117
nosema	44x1 cell
nosemaDataset	44x3 table
not_nosema	44x1 cell
numAnchors	8
options	1x1 TrainingOptionsADAM
poruka	'Broj otkrivenih nosema celija je: 0'
precision	[1;1;1;0.6667;0.7500;0.8000;0.8333]
recall	[0;0.0073;0.0146;0.0146;0.0219;0.0292;0.0365]
scores	[]
shuffledIndices	1x44 double
srcdir	'C:\Users\Korisnik 01\Desktop\nozema_boris'
tbl	44x3 table
testData	1x1 CombinedDatastore
testDataTbl	2x3 table
testIdx	[43,44]
trainingData	1x1 CombinedDatastore
trainingDataForE...	1x1 TransformedDatastore
trainingDataTbl	39x3 table
trainingIdx	1x39 double
validationData	1x1 CombinedDatastore
validationDataTbl	3x3 table
validationIdx	[40,41,42]

Command Window

```

*****
Detector training complete.
*****

Broj otkrivenih nosema celija je: 0
IdleTimeout has been reached.
Parallel pool using the 'Processes' profile is shutting down.

>>

```

Details

Type here to search

84°F Sunny 11:00 AM 7/11/2023

# 4) Training

```

inputSize = [1344 1824 3]; %
className = "nosema";
numAnchors = 8; % "tiny-yolov4-coco" ...
[anchors,meanIoU] = estimateAnchorBoxes(trainingDataForEstimation,numAnchors);
detector = yolov4ObjectDetector("tiny-yolov4-coco",className,anchorBoxes,inputSize=inputSize);
augmentedTrainingData = transform(trainingData,@augmentData);
montage(augmentedData,BorderSize=10)
options = trainingOptions("adam",...
GradientDecayFactor=0.9,...
SquaredGradientDecayFactor=0.999,...
InitialLearnRate=0.001,...
LearnRateSchedule="none",...
MiniBatchSize=1,...
L2Regularization=0.0005,...
MaxEpochs=10,... % take free to change the number of epochs for optimal solution
CheckpointPath=tempdir,...
ValidationData=validationData);

[detector,info] = trainYOLOv4ObjectDetector(augmentedTrainingData,detector,options);

```

# 4) Training (Transfer learning) using YOLO v4 model

The **You Only Look Once version 4 (YOLO v4)** object detection network:  
**backbone, neck, and head.**

**The backbone** can be a pretrained convolutional neural network such as CSPDarkNet53 trained on COCO or ImageNet data sets.

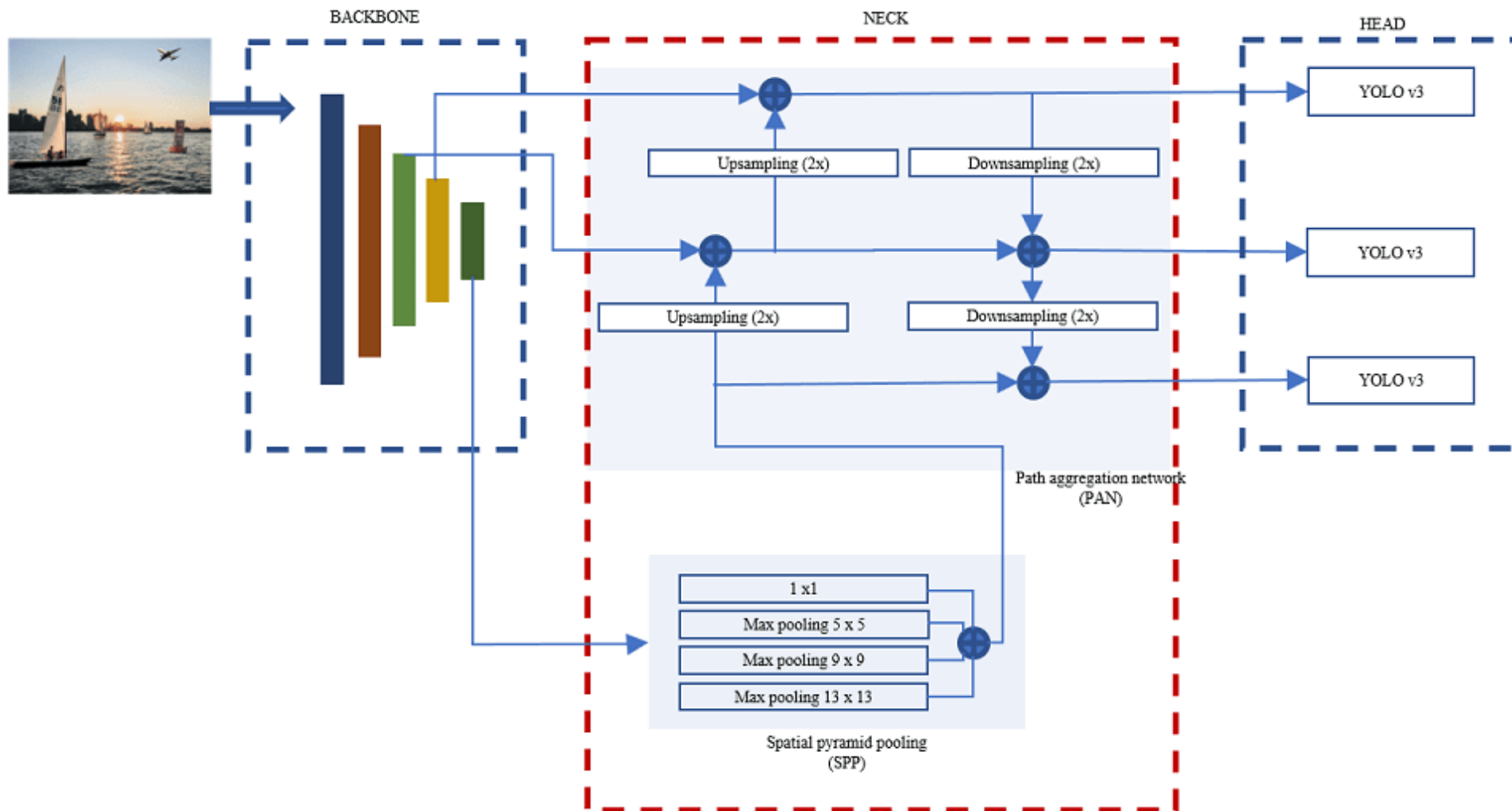
***The backbone of the YOLO v4 network acts as the feature extraction network that computes feature maps from the input images.***

**The neck** connects the backbone and the head. Composed of a spatial pyramid pooling (SPP) module and a path aggregation network (PAN). *Concatenates the feature maps from different layers of the backbone network and sends them as inputs to the head.*

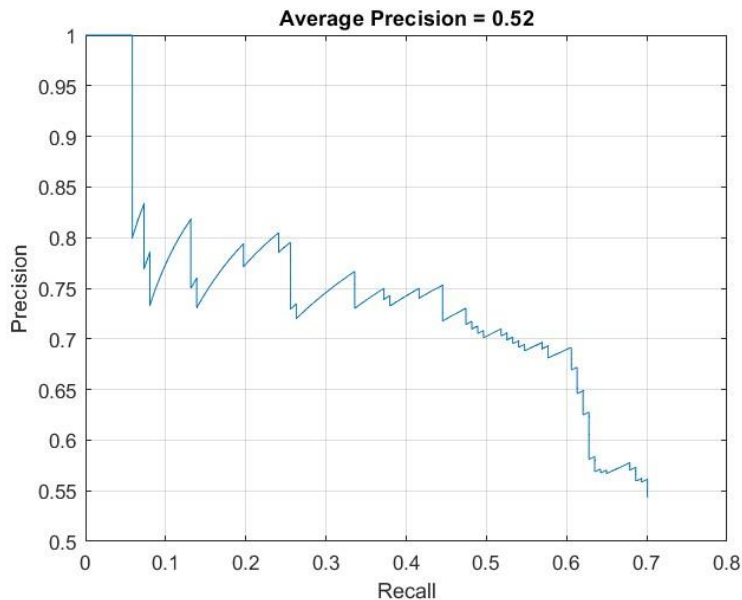
**The head** *processes the aggregated features and predicts the bounding boxes, objectness scores, and classification scores.* The YOLO v4 network uses one-stage object detectors, such as YOLO v3, as detection heads.



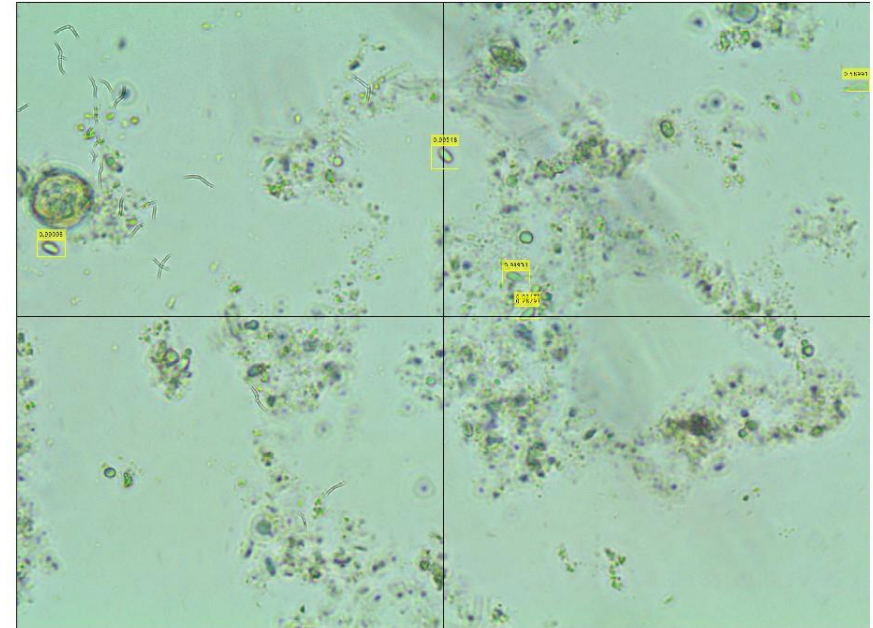
<https://www.mathworks.com/help/vision/ug/getting-started-with-yolo-v4.html>



# 5) Testing and validation of DL model for detection of nosema cells



After 60 epochs of training



Detection of nosema cells using our trained YOLO v4 DL model

**Recall** is a ratio of true positive instances to the sum of true positives and false negatives in the detector, based on the ground truth.

**Precision** is a ratio of true positive instances to all positive instances of objects in the detector, based on the ground truth.

For a multiclass detector, recall and precision are cell arrays, where each cell contains the data points for each object class.

# Conclusion

- **The future belongs to intensive AI usage**
- **Future “smart solutions”, need “appropriate knowledge”**
- <https://www.youtube.com/watch?v=vT1JzLTH4G4&list=PLC1qU-LWwrF64f4QKQT-Vg5Wr4qEE1Zxk>
- <https://www.mathworks.com/help/vision/ug/object-detection-using-yolov4-deep-learning.html>
- [https://d2l.ai/chapter\\_preface/index.html](https://d2l.ai/chapter_preface/index.html)
- <https://www.deeplearningbook.org/>

THANK YOU!



**VIRAL**

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AGRICULTURAL LEARNING